Orbiting Wide-angle Light-collectors (OWL)

Structural Analysis

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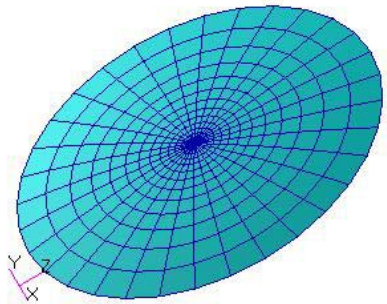
Analysis Outline

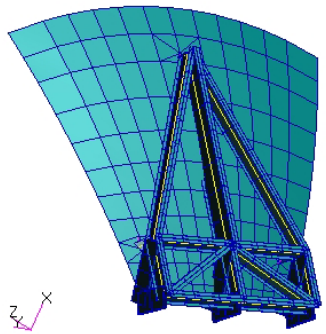
- Components Analyzed
- Assumptions
- Analysis Results
- Issues and Future Analyses

Components Analyzed

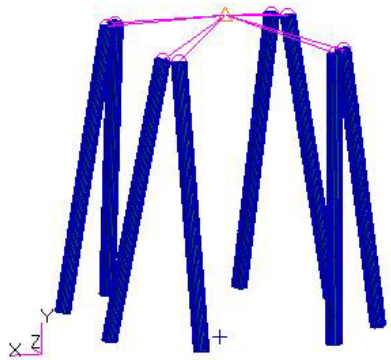
- Models of the following components were constructed and analyzed:
  - Corrector Plate
    - Effectiveness of domed design
      - 10 G gravity loading
      - Fixed base dynamics



  - Mirror segment + Bracket
    - Optimization
      - Fixed base dynamics
    - 15 G stresses



  - Detector plate support struts
    - Fixed base dynamics
    - Buckling



Modeling Assumptions

- Models were constructed in NASTRAN
  - Built using PATRAN software
  - Models in English units
- Assumptions for specific components
  - Corrector Plate
    - Material – Fused silica
    - Varying thickness from 13mm at edge to 3mm at center
    - 3000 mm diameter with 100 mm dome peak
  - Mirror Segment
    - Materials – M55J composite face sheets (.06″) with 2″ thick light-weight aluminum honeycomb core (2.1 lbs/ft^3)
    - 3 point mount to bracket

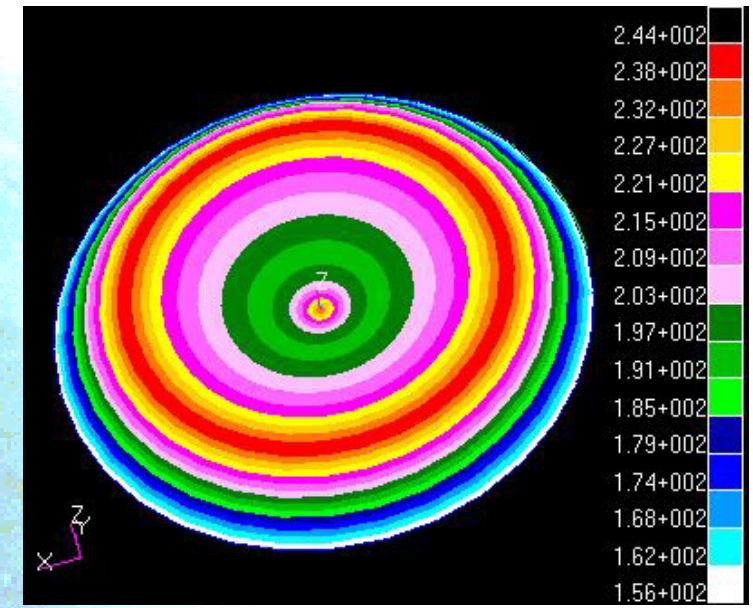
Modeling Assumptions (Cont.)

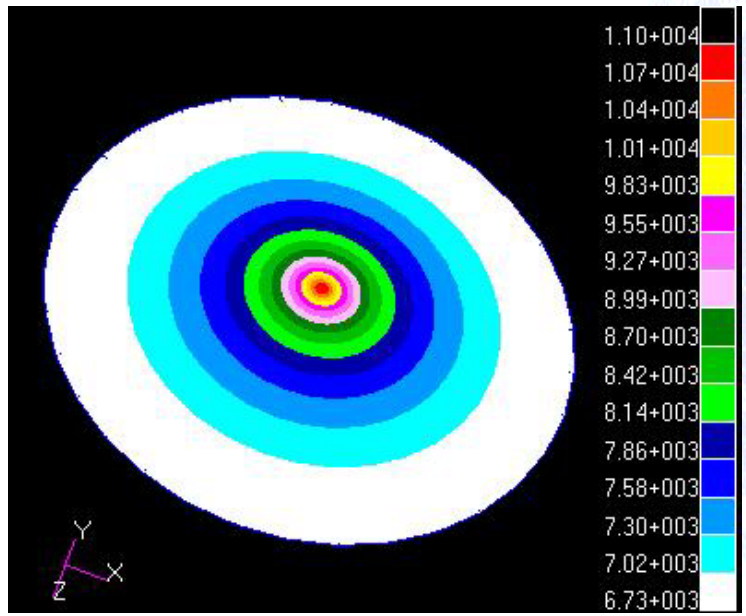
- Mirror Bracket
  - Materials – M55J composite structure with Ti flexure blades at adjustment points
  - Truss structure with I beam cross section segments

- Focal Plane Support Tubes
  - Material – M55J composite
  - Circular cross section tubes (6.0″ outer diam., and .08″ thick walls)
  - Support 1000 lbs (455 Kg)
    - Represented as rigid, lumped mass

Analysis Results

- Corrector Plate
  - Doming makes all the difference
    - FF for domed=83 Hz (flat=5 Hz)
    - 10g Peak stress for domed = 250 psi (flat=11000 psi)

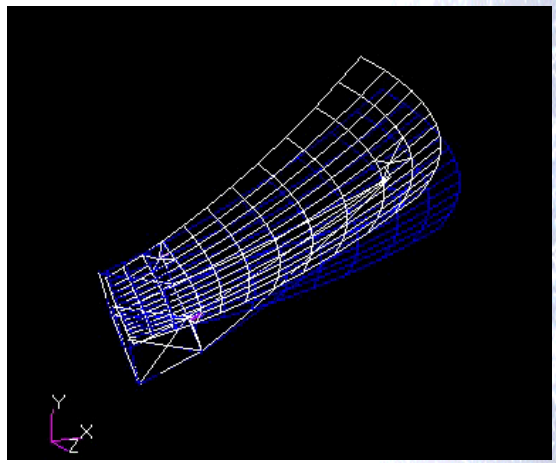




Analysis Results (Cont.)

- Mirror Segment and Bracket
  - 2″ core with .06″ face sheets provides very stiff structure
    - FF = 61 Hz (rigidly held at 3 bracket attach points)
  - Bracket design is more challenging
    - Difficult to get FF much above 20 Hz
  - 15 G stresses generally low
    - Peak in mirror-to-bracket connectors

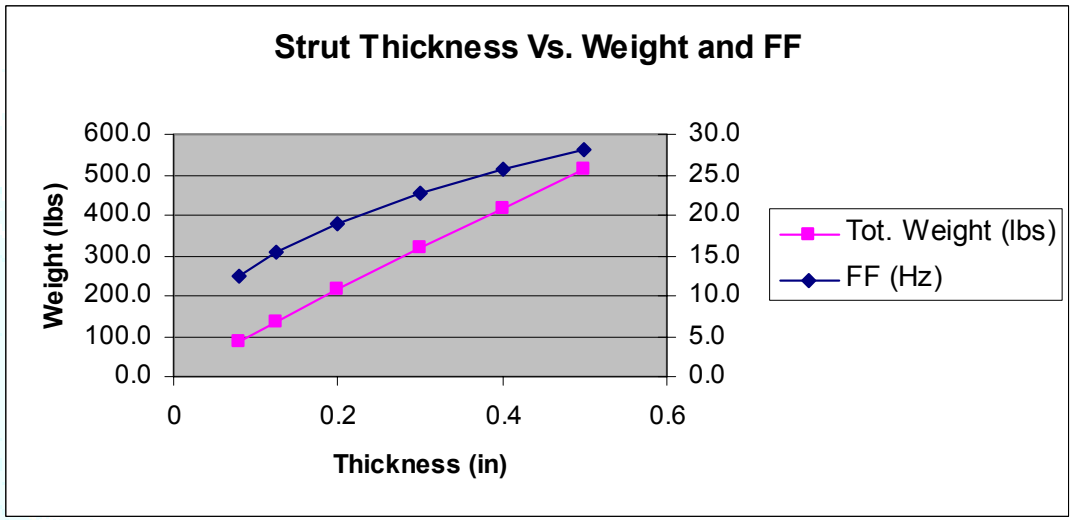
Maximum Stresses (in PSI) due to 15 G Gravity Loading			
Component	15G X	15G Y	15G Z
Mirror Segment	950.	1120.	795.
Bracket	7500.	7740.	6460.
Mount Flexures	8470.	20900.	11000.



Mode 1 - 20.7 Hz

Analysis Results (Cont.)

- Detector Support Tubes
  - Buckling not an issue
    - Critical buckling load >>20 G's
  - Tubes optimized to keep
  - Difficult to keep frequency above 20 Hz and weight reasonable without increasing strut diameter.



Issues and Future Analyses

- Corrector Plate
  - Analysis needs to be done on segmented dome design
- Mirror Segments and Bracket
  - Fundamental frequency of mirror segments may be too low to survive launch environment
  - Bracket needs more optimization
  - May be necessary to tie mirror segments together for launch to provide additional stiffness
  - Thermal distortion analysis may indicate possible use of higher CTE materials for bracket (rather than composites)
- Detector Plate Support Structure
  - Strut geometry far from optimum
    - Frequency rather low
  - May require larger diameter struts
    - Increased obscuration
  - Is 1000 lbs support weight correct?

Issues and Future Analyses (Cont.)

- Additional work to be done
  - S/C interface structure needs to be designed and analyzed
  - Detailed modeling of detector plate assembly and corrector plate support structure
  - Modeling of cover and cover mechanism
  - Overall systems analysis
    - Dynamics of instrument in launch and on-orbit configurations
      - Are mirror ties or other redundant restraints necessary to hold mirror segments for launch?
    - Thermal distortion analysis
      - May help determine whether aggressively low CTE materials are really necessary
    - Detailed stress analysis
      - May be certain areas (such as detector support structure) that will be stress driven and need detailed analyses